Preliminary Assessment Report

San Mateo Creek Legacy Uranium Sites

CERCLIS ID NMN00060684
McKinley and Cibola counties, New Mexico

DRAFT

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1.0 Introduction

Under the authority of the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"), as amended, 42 United States Code ("U.S.C.") §§ 9601 to 9675, the New Mexico Environment Department ("NMED") Superfund Oversight Section ("SOS") has conducted a Preliminary Site Assessment ("PA") of the San Mateo Creek basin legacy uranium mine and millsites (Site), which is located in Cibola and McKinley counties, New Mexico (CERCLIS ID NMN00060684; Figure 1).

The objective of the PA is to evaluate the Site using the Hazard Ranking System (Ref. 1) and the Superfund Chemical Data Matrix (Ref. 2) to determine if a threat to human health and the environment exists such that further action under CERCLA is warranted.

2.0 Site information

2.1 Location and description

The San Mateo Creek basin (Hydrologic Unit Code ["HUC"] 1302020703), by which the boundary of the Site is defined, comprises approximately 321 square miles within the Rio San Jose drainage basin (Ref. 3, 4) in McKinley and Cibola counties, New Mexico (Ref. 5; see Figure 1). This basin is located within the Grants Mineral Belt ("GMB"), which is an area of uranium mineralization occurrence approximately 100 miles long and 25 miles wide encompassing portions of McKinley, Cibola, Sandoval and Bernalillo counties (Ref. 6, p. 8), and includes the Ambrosia Lake mining district (Ref. 6, p. 17). Main access into the Site is provided by New Mexico State Roads 605 and 509.

The 85 legacy uranium mines with recorded production and 4 legacy uranium millsites comprising the Site (Ref. 7) may have contributed to degradation of ground water quality within this basin. Some background ground water contaminant concentrations associated with remediation of the Homestake Mining Company ("HMC") Superfund Site ("HMC Site;" NMD007860935; Ref. 8) exceed Federal (Ref. 9 and 10) and State (Ref. 11) drinking water standards. Additionally, ground water quality data collected by HMC from some monitor wells that are completed in the San Andres aquifer (Ref. 12, p. 8.0-4; Ref. 13; Ref. 14) show increasing uranium concentrations, some exceeding Federal and State drinking water standards. These uranium concentrations are unlikely to be attributable to contamination from the HMC site because recharge to eastward-flowing ground water in the San Andres aquifer is west of the HMC site; vertical hydrologic communication to overlying aquifers impacted by contamination from the HMC site is limited (Ref. 12, p. 8.0-1).

2.2 Geologic setting

The southern end of the San Mateo Alluvial system has been impacted by contamination from the HMC Site. This alluvial system extends from the northeast to the south of the HMC site, following the San Mateo Creek drainage (Ref. 15, p. 2-1). Underlying the Alluvial aquifer in this vicinity is the Upper Triassic (Ref. 6, p. 12) Chinle Formation, which is a predominantly shale formation 800 feet in thickness. Three aquifer units are present within this formation in the southern part of the basin. The highest 2 aquifers are the Upper and Middle Chinle sandstones. The lowest aquifer, the Lower Chinle, is a fractured shale with variable hydrologic yield of generally poor quality water. All three of these aquifers subcrop with the Alluvial aquifer, connecting the Alluvial aquifer and each of the Chinle aquifers hydrologically in the vicinity of the Homestake site. The San Andres regional aquifer underlies the Chinle Formation in this area (Ref. 15, p. 2-1—2-2).

Most uranium production in New Mexico has come from the Upper Jurassic Westwater Canyon member of the Morrison Formation in McKinley and Cibola counties (Ref. 6, p. 9; Ref. 16, p. 1, 6). This unit consists of interbedded fluvial arkosic sandstone, claystone, and mudstone with an average thickness of 250 feet, thinning to 100 feet southward and eastward, and is a major aquifer within the GMB (Ref. 6, p. 9). Three types of uranium deposits that are found in the Westwater Canyon member are primary (trend or tabular; average ore grade greater than 0.20% U_3O_8), redistributed (stack; average grade 0.16% U_3O_8), and remnant-primary (average grade 0.20% U_3O_8; Ref. 16, p. 6, 8). The overlying Brushy Basin member of the Westwater Canyon member includes the Poison Canyon Sandstone, from which uranium also has been mined (Ref. 6, p. 9, 13).

Additionally uranium deposits were discovered at Haystack Butte in 1950 within the Upper Jurassic Todilto Limestone, which occurs within the San Raphael Group underlying the Morrison Formation (Ref. 6, p. 12, 13; Ref. 16, p. 4); these accounted for approximately 2% of production from the "Grants uranium district" between 1950 and 1981 (Ref. 16, p. 11). More than 100 uranium mines and occurrences in the Todilto Limestone are documented in New Mexico, with production reported from 42 of these mines—mostly located within the "Grants uranium district" (Ref. 16, p. 12).

Thin zones of minor uranium mineralization have been produced from shale and lignite within the Lower Cretaceous Dakota Sandstone, which overlies the Morrison Formation (Ref. 6, p. 13; Ref. 16, p. 12). Uraniferous collapse-breccia pipe deposits, which are vertical or steeply-dipping cylindrical features bounded by ring fractures and faults filled with heterogeneous brecciated "country" rock, also are found in the Grants area (Ref. 16, p. 12).

Quaternary-age unconsolidated to semi-consolidated alluvial, eolian, and terrace deposits overlie bedrock in valley bottoms; these deposits are generally less than 200 feet in thickness (Ref. 6, p. 13).

2.3 Demographics

Average household size within McKinley County is 3.44 people (Ref. 17); average population density is 13 people/square mile (Ref. 18, p. 1). Within Cibola County, the average household size is 2.95 people (Ref. 19, p. 1); the average population density in Cibola County is 6 persons/square mile (Ref. 18, p. 2).

The community of San Mateo, which is located within the San Mateo Creek basin, has a municipal water supply that serves 192 residents (Ref. 20, p. 1). No demographic data for the community of Haystack were found.

The communities of Grants, Milan, and Bluewater are located just outside of the boundaries of the proposed Site. In 2000, Grants had a population of 8,806 people with average household size of 2.61 people (Ref. 21). Milan in 2000 had a population of 1,891 with an average household size of 2.81 people (Ref. 22). No population data were found for Bluewater.

2.4 Climate

The average annual maximum temperature at the Grants Airport is 67.8° F; the highest maximum temperature of 88.4° F occurs in July. The average annual minimum temperature is 33.0° F; the lowest minimum temperature of 14.4° F occurs in December. The average annual total precipitation is 10.40 inches (in.). The maximum average precipitation of 2.03 in. occurs in August; the minimum average precipitation of 0.44 in. occurs in February. Average annual snowfall is 12.3 in., with the maximum snowfall of 4.1 in. occurring in December (Ref. 23).

The average annual maximum temperature at the weather station in San Mateo, New Mexico is 61.7° F; the highest maximum temperature of 83.1° F occurs in July. The average annual minimum temperature is 34.6° F; the lowest minimum temperature of 16.0° F occurs in January. The average annual total precipitation is 8.66 in. The maximum average precipitation of 2.11 in. occurs in August; the minimum average precipitation of 0.28 in. occurs in February and December. Average annual snowfall is 9.7 in., with the maximum snowfall of 3.1 in. occurring in December (Ref. 24).

The prevailing wind direction (i.e., the direction from which the wind blows) at the Grants airport is northwesterly (Ref. 25, p. 10); however this may not be entirely representative of wind direction within the San Mateo Creek basin (Ref. 26).

At a monitoring location within Bluewater Creek (elevation 7,624 feet), the prevailing wind direction was west-southwesterly during 2007, at an average speed of 9.0 miles per hour (mph) (Ref. 27, p. 2). At a nearby monitoring location on Bluewater Ridge, the prevailing wind direction is south-southwesterly at an average speed of 4.3 mph (Ref. 28, p. 2).

2.5 Operational history and ownership

Land ownership within the area is a complex of Indian, Federal, State, and private (Ref. 29; see Figure 3).

Uranium ore was discovered in the Todilto Limestone at Haystack Butte in 1950, and production began prior to mill construction in the area by open-pit mining. Uranium was discovered at Ambrosia Lake in 1955 (Ref. 16, p. 4). Downdip drilling from the initial surface discoveries delineated ore bodies within the Poison Canyon and Westwater Canyon members of the Morrison Formation. The discovery of large subsurface uranium deposits within the Westwater Canyon member resulted in establishment of two-thirds of the active uranium mines in

New Mexico within the Ambrosia Lake district by 1980; most of these mines were underground room-and-pillar operations at depths averaging 900 feet (Ref. 6, p. 17).

Anaconda Copper

The Anaconda Copper Company built the Bluewater mill in 1953 to process ore from the Jackpile mine (Ref. 16, p. 5; Ref. 30, p. 1). This mill used a carbonate-leach process with a capacity of 300 tons per day and operated until 1959. An acid-leach mill was operated from 1957 through 1982, reaching a production capacity of 6,000 tons per day in 1978 (Ref. 30, p. 1). ARCO Coal Company reclaimed the site between 1991 and 1995 for long-term DOE stewardship under the Legacy Management program (Ref. 16, p. 5; Ref. 30, p. 1-2).

Two mills were built in 1957 at the present Homestake millsite. The first closed in 1962. Homestake originally owned the second larger mill in a partnership; when that partnership was dissolved in 1981, Homestake became the sole owner. Mill production ceased in 1981, but resumed in 1988 to process ore from the Section 23 mine and Chevron's Mount Taylor mine. The mill was demolished in 1990 (Ref. 16, p. 5), *and the site ground water restoration is ongoing* (Ref. 12). In 2001, Homestake has merged with Barrick Gold Corporation (Ref. 16, p. 5). Barrick

Kermac

Kermac Nuclear Fuels Corp., which was a partnership of Kerr-McGee Oil Industries, Inc., Anderson Development Corp., and Pacific Uranium Mines Co., built the Kerr-McGee uranium mill at Ambrosia Lake in 1957-58. Quivira Mining Co., a subsidiary of Kerr-McGee Corp. (later Rio Algom Mining LLC, currently BHP-Billiton) became the operator of the mill in 1983. Operation began in 1958; from 1985 through 2002 the mill produced only from mine waters from the Ambrosia Lake underground mines. (Ref. 16, p. 5). The tailing impoundment at the site contains 33 million tons of uranium ore (*sic*) within an area of 370 acres (Ref. 31).

BHP-Billiton

Phillips

UNC

Phillips Petroleum Co. built a mill at Ambrosia Lake in 1957-58, and began to process ore from the Ann Lee, Sandstone, and Cliffside mines in 1958. United Nuclear Corporation acquired the property in 1963 when the mill closed (Ref. 16, p. 5). United Nuclear Corporation operated an ion exchange system to extract uranium from mine water in the late 1970s to early 1980s. All operations ended in 1982 (Ref. 32, p. 1).

2.6 Regulatory history

Some mines are inventoried by the New Mexico Bureau of Geology and Mineral Resources, the Navajo Nation Abandoned Uranium Mine (AUM) program, and/or the U.S. Bureau of Land Management; some minesites also have been reclaimed under Federal or State jurisdiction (Ref. 7; see Table 1).

In 1978, the U.S. Environmental Protection Agency (EPA) proposed to regulate minewater discharge under the NPDES permit program. The permit for the Kerr-McGee Section 35 and 36 mines was terminated when Kerr-McGee undertook controlled spreading and irrigation with mine dewatering effluent. Kerr-McGee obtained a State ground water discharge permit for IX ion exchange ("IX") facilities associated with the Section 35 and 36 mines in 1979-1980; this permit currently is in stand-by status (Ref. 33, p. 2).

ARCO DOE

The Bluewater Mill site was remediated by the Atlantic Richfield Company ("ARCO") under the U.S. Nuclear Regulatory Commission ("NRC") operational license, and was subsequently transferred to DOE custody and long-term care in 1997 (Ref. 34) under the jurisdiction of Title II of the Uranium Mill Tailings Radiation Control Act ("UMTRCA;" Ref. 30, p. 1). Prior to this transfer, the NRC amended the operational license to include alternate concentration limits ("ACLs") for the Alluvial and San Andres aquifers, which were impacted by the site, at established point of compliance wells (Ref. 30, p. 2; Ref. 35, p. 1, 3, and 4; see Table 2).

Homestake

Homestake Mining Company is currently remediating the Homestake uranium millsite under the regulation of NRC license SUA-1471 and NMED discharge permit DP-200 (Ref. 12, p. 1.1-1). This site also is on the National Priorities List ("NPL") as well (CERCLIS ID NMD007860935; Ref. 36, p. 17).

The site status of the Ambrosia Lake/Rio Algom mill was changed to reclamation in August 2003. NRC issued a license amendment for ACLs in February 2006, after which all ground water corrective actions were discontinued (Ref. 31).

The DOE remediated the Ambrosia Lake/Phillips mill site between 1987 and 1995 as part of the 1978 UMTRCA Title I program, and currently monitors the site as part of the Legacy Management program (Ref. 16, p. 5; Ref. 32, p. 1-2; Ref. 37).

2.7 Previous environmental investigation

Numerous environmental investigations associated with remediation of the 4 millsites within the Site have been conducted under the regulatory authority of the NRC; documents from these investigations are not detailed herein, but are available through the ADAMS website interface (http://adamswebsearch.nrc.gov/scripts/securelogin.pl).

The New Mexico Health and Environment Department ("EID") documented a study of the uranium mining impacts on surface and ground water within the Grants mineral belt (Ref. 6).

The New Mexico Energy, Mineral and Natural Resources Department ("NMEMNRD") has compiled a database of uranium legacy mine and mill site information from multiple sources (Ref. 7), which forms the basis of this investigation. The locations of the mines with reported production and mills from this database are shown on Figure 1 and on Table 1. Other minesites without reported production in this database are not addressed herein.

Now BHP-BILLITON

NMED sent letters to the Rio Algom Mining Company in 2005 and 2006, requiring compliance with 20.6.2.1203 NMAC for reporting soil contamination related to mine dewatering activities for the Section 35 and 36 mines (Ref. 33, p. 1).

Individual mine- and millsites within the Site boundary that have been investigated under CERCLA are summarized in Table 3.

The U.S. Forest Service has proposed CERCLA investigation of the San Mateo mine in 2008 (Ref. 38, p. 21).

3.0 Site investigation

3.1 Source/waste characteristics

Both surface and underground mining methods contributed waste to natural surface drainage systems. Liquid wastes were almost exclusively derived from underground operations, while both operational methods contributed solid wastes. Underground mines generally produce less waste rock than surface mines, but contaminant concentrations can be higher (Ref. 6, p. 19). Mine waste piles may include barren overburden, low-grade ore (i.e., below economic value), and/or ore stockpiled for later milling (Ref. 6, p. 54). The spoils areas in which this waste rock is stored usually were not bermed to control runoff (Ref. 6, p. 19). EID sampled mine wastes from minesites within the Site to test contaminant leachability (Ref. 6, p. 34-35). Leaching testing from 37 composite samples of uranium mine waste that were designed to simulate the leaching effects of natural rainfall both before and after contacting alkaline rich soils indicated that contaminants have a relatively low potential for leaching or for significantly degrading ground water quality (Ref. 6, p. 57).

A 1985 survey of 14 uranium mines located within the GMB, which includes individual minesites located within the proposed Site, on Federally-owned surface and mineral lands showed gamma radiation levels between 6 and 888 microroentgens per hour, with the highest reading taken from mine waste and openings (Ref. 39, p. 2-4; see Table 1).

Sampling results of waste rock materials from the Poison Canyon Mining District are summarized in Table 4. Nearly all contaminant concentrations in the waste materials are higher than in the background samples by one to two orders of magnitude (Ref. 40).

Waste material from the Navajo-Brown Vandever uranium mine (NMD986669117; see Table 3) was used to pave the road to this site, and approximately 75 people were identified to live with one-quarter mile of the site in 1990 (Ref. 41). owner) opr ?

EID investigators concluded that 10 to 20 percent of all abandoned mines in the GMB had waste piles that are directly eroding into local drainage channels (Ref. 6, p. 55). EID collected runoff samples from several sites to assess contaminant input from mine waste piles within the Ambrosia Lake mining district (Ref. 6, p. 54); observations from this program indicated that runoff contaminant concentrations exceeded natural concentrations by up to several hundred times. Samples collected within the Ambrosia Lake mining district indicated that uranium and molybdenum maxima concentrations in waste pile runoff exceed natural runoff concentrations by over 2 orders of magnitude. Maximum arsenic, selenium, and vanadium concentrations exceed maximum natural runoff concentrations by 6 to 8 times (Ref. 6, p. 54-55). Runoff sampling in the vicinity of a large waste pile associated with the Old San Mateo mine showed elevated levels of gross alpha and gross beta particle activities, $radium_{226}$, natural uranium, arsenic, lead, molybdenum, selenium, and vanadium, in comparison to natural sediments, to persist at least 550 meters downstream from the waste pile (Ref. 6, p. 57).

Water produced from mine dewatering and aquifer depressuring operations was discharged to settling ponds and drainage channels (Ref. 6, p. 20-21). Mine water production within the Ambrosia Lake mining district was continuous after 1956, with peak production in the early 1960s (Ref. 6, p. 66). During the period 1979-1981, mine discharges of 1,500 gallons per minute ("gpm") to San Mateo Creek sustained approximately 3 miles of perennial flow; 2,300 gpm discharge to Arroyo del Puerto sustained perennial flow of approximately 5 miles (Ref. 6, p. 66, 68). In 1977, approximately 2,900 gpm were being discharged to San Mateo Creek from mine dewatering; by spring of 1978, most of this water was diverted for irrigation and to an adjacent drainage basin (Ref. 6, p. 72).

Minewaters generally contain higher concentrations of sodium and sulfate than natural runoff (Ref. 6, p. 84). Raw minewaters from the GMB had elevated concentrations of gross alpha and beta particle activities, $radium_{226}$, $lead_{210}$, natural uranium, molybdenum, selenium, and dissolved solids—particularly sulfate; elevated concentrations barium, arsenic, and vanadium also were observed (Ref. 6, p. 80). Total dissolved solid ("TDS") concentrations in minewaters from the western part of the Ambrosia Lake mining district were 1,200 to 1,800 milligrams per liter ("mg/l"). Minewater in eastern part of the Ambrosia Lake mining district usually had a few hundred mg/l TDS.

For compliance with federal National Pollutant Discharge Elimination System (NPDES) permits, produced waters were treated with the additions of a flocculent and barium chloride to reduce suspended solid concentrations and to co-precipitate radium (Ref. 6, p. 20-21). Effluent discharged to San Mateo Creek contained 300 to 600 mg/l TDS. Out of 9 trace elements for which treated minewaters were analyzed, molybdenum, selenium, and uranium concentrations were consistently higher than in natural runoff. Median total uranium concentration in mine effluents from the Ambrosia Lake mining district was 1.6 mg/l, which was over 16 times greater than the corresponding median concentration in natural runoff. Median total molybdenum concentration in minewater from the Ambrosia Lake mining district was 0.80 mg/l, which compares to the few samples of natural runoff in which total molybdenum concentration exceeded 0.01 mg/l. Total median selenium concentrations in treated minewater generally are less than 0.04 to 0.09 mg/l; however some treated effluents within the district approach 1.0 mg/l. Median total selenium concentration in natural runoff within the Ambrosia Lake mining district is 0.03 mg/l. Arsenic, vanadium, and barium, the latter of which is added in the treatment process, are occasionally detected in significant concentrations in minewaters; cadmium, lead, and zinc are usually below detectable concentrations (Ref. 6, p. 87). Median total barium concentration was 0.212 mg/l (Ref. 6, p. 88). Elevated concentrations of arsenic and vanadium in treated effluent (0.05 and 0.17 mg/l respectively) were only observed in association with the Homestake ion exchange facility, which was located within the Ambrosia Lake area (Ref. 6, p. 87, 97).

With the exception of natural uranium, total concentrations of radionuclides in treated minewaters are less than those in natural runoff. Most mines discharged minewaters with total concentrations of $radium_{226}$ of 6 picocuries per liter ("pCi/L") or less; about 30 percent of this may have been in the dissolved form. However, EID collected effluent samples with total $radium_{226}$ concentrations up to 200 pCi/L; these higher concentrations were attributed to the existence of "upset" conditions in the treatment process. Neither thorium isotopes nor $radium_{228}$ were generally present in detectable concentrations. Total $lead_{210}$ concentrations up to 33 pCi/L and total $polonium_{210}$ concentrations up to 15 pCi/L were detected from treated minewaters; higher concentrations—up to several hundred pCi/L—may have occurred during periods of ineffective minewater treatment (Ref. 6, p. 90).

Generally treated minewaters contained trace elements and radionuclides in dissolved form; typically, these dissolved contaminant concentrations comprised more than 50% of the total. More than 85% of the total concentration of gross alpha activity, molybdenum, selenium and natural uranium occurred in the dissolved fraction, while $radium_{226}$ concentrations averaged about 30% of the total (Ref. 6, p. 87). With the exception of natural uranium, radionuclide concentrations in minewaters in the dissolved phase were higher in comparison to concentrations in natural runoff (Ref. 6, p. 90). Dissolved gross alpha levels were several hundred to over 1,000 pCi/L in dewatering effluents (Ref. 6, p. 90). Only $radium_{226}$ and $lead_{210}$, among trace elements and radionuclides identified to have had elevated concentrations in effluent, underwent significant partitioning changes between dissolved and suspended phases with distance traveled; these constituents were usually became bound to precipitates and sediments and were lost from solution shortly after release. Once precipitated or bound to stream sediments, minewater contaminants could be moved downstream during natural or artificially-induced flow events. (Ref. 6, p. 90, 92). Within relatively sediment-free stream channels, these contaminants would stay in solution; dissolved $radium_{226}$ concentrations along the Arroyo del Puerto ranged between 3 and 6 pCi/L. Dissolved $radium_{226}$ concentrations also were attenuated by the alkaline and oxidizing conditions that are found in the GMB (Ref. 6, p. 109). Concentrations of uranium, molybdenum, and major dissolved solids generally were not rapidly attenuated in the receiving stream channels (Ref. 6, p. 92).

Mechanisms that were inferred to reduce contaminant concentrations most effectively in alluvial ground water impacted by minewater effluents include dilution, surface adsorption, cation exchange, precipitation, hydrodynamic dispersion, and molecular diffusion.

Sludges in treatment ponds that are created from settling, flocculation, and precipitation have elevated concentrations of $radium_{226}$ and other radionuclides, with concentrations of the former exceeding 200 pCi/gram (Ref. 6, p. 82). Separate ion-exchange treatment reduced elevated concentrations of dissolved uranium (Ref. 6, p. 20-21). Although treatment reduced concentrations of radium$_{226}$, lead$_{210}$, polonium$_{210}$, natural uranium, and gross alpha activity, other constituent concentrations were not affected (Ref. 6, p. 80).

3.2 Ground water pathway

The ground water pathway assesses the threat to human health and the environment by determining whether hazardous substances are likely to have been released to ground water; and whether any receptors are likely to be exposed to hazardous substances as a result of a release.

3.2.1 Hydrogeology

Alluvial aquifers along San Mateo Creek generally yield less than 50 gpm, where water occurs from a few feet to 100 feet below the surface (Ref. 6, p. 14). Available data indicate the presence of little alluvial ground water along the Arroyo del Puerto under pre-mining conditions (Ref. 6, p. 95). Near Ambrosia Lake, the Alluvial aquifer presently yields less than 150 gallons per day, and is expected to return to pre-mining/pre-milling conditions of little to no saturation (Ref. 32, p. 2). Alluvial ground water flows generally correspond to the slope of the land along San Mateo Creek (Ref. 6, p. 14). Depths to ground water in 1981 along San Mateo Creek were generally near 60 feet near its intersection with the tributary Arroyo del Puerto. Along the latter watercourse, 1981 depths to water were approximately 24 feet (Ref. 6, p. 16). Measurements conducted near the San Mateo Creek gaging station in 1980 showed little effect on alluvial ground water levels from intense summer thunderstorms, but did demonstrate a hydraulic response to late winter and spring stream flow (Ref. 6, p. 74).

Bedrock aquifers are recharged where streamflows or minewater discharge intersect bedrock subcrops and outcrops (Ref. 6, p. 13, 77). Additional bedrock aquifer recharge occurs where saturated valley fill overlie permeable bedrock with a downward hydraulic gradient (Ref. 6, p. 77). Mine dewatering has decreased aquifer water levels significantly, especially in the Morrison Formation (Ref. 6, p. 13). The Westwater Canyon member of the Morrison Formation is a principal bedrock aquifer in the area, yielding up to several hundred gpm (Ref. 6, p. 13). Mine dewatering drained virtually all of this formation and altered its flow system. Prior to dewatering, ground water generally flowed to the northeast and east in the direction of the dip of the strata (Ref. 42, p. 3). Other reliable aquifers include the Dakota Sandstone, the Glorieta Sandstone, and the San Andres Limestone.

3.2.2 Ground water use

Ground water uses in the area include domestic, limited agricultural, and livestock watering, with the latter primarily derived from alluvial wells (Ref. 6, p. 14). Within the boundaries of the proposed Site, drinking water systems for the community of San Mateo (Water system no. NM3525733; Ref. 20), Tri-State Generating Station (Water system no. NM3595017; Ref. 43), ARCO (Anaconda) Coal Company—Bluewater Mill (Water system no. NM3591033; Ref. 44), and

Homestake Mill (Water system no. NM3598133; Ref. 45) are listed with the NMED Drinking Water Bureau.

The water supply system for the community of San Mateo has 2 wells, of which only one is currently active. The system serves 192 people through 61 service connections (Ref. 20, p. 1). The supply wells of this system are completed in the Point Lookout Sandstone (Ref. 42, p. 2). NMED queried for non-coliform sample results available on-line; no occurrences of analyte concentrations that exceed Federal (Ref. 9; Ref. 10) or State (Ref. 11) drinking water standards were noted among the data available (Ref. 20).

The Tri-State Generating Station system is an industrial/agricultural system that serves a population of 125 from 10 wells and a reservoir; 2 of the wells are shown to be inactive (Ref. 43, p. 1). NMED queried for non-coliform sample results available on-line; one sample collected between 2004 and 2007 exceeded the MCL for gross beta particle activity (Ref. 9; Ref. 43, p. 2).

The Bluewater Mill system served a population of 60 from 5 service connections that were sourced from 4 wells. The wells are currently shown to be inactive, and no analytical data for this system were available on-line (Ref. 44).

The Homestake Mill system served a population of 24 through 17 connections, and was sourced by one well. This well currently is shown to be inactive, and no analytical data for this system were available on-line (Ref. 45).

Three wells and a spring within a 4-mile radius of the Navajo-Brown Vandever Mine (CERCLIS ID NND986669117; see Table 3) were noted during an inspection, with ground water levels in 1990 in 2 wells within 100 feet of an adit depth. At that time, these wells were a portion of the water supply to 430 people (Ref. 41).

Due to the complexity of the Site, ground water usage and potential impacts to wells located within Site target distance limits was not analyzed in accordance with Ref. 46, p. 61 (Ref. 47, p. 8). Figure 4 shows details of wells registered with the New Mexico Office of the State Engineer, and Table 5 summarizes well usage, within the San Mateo Creek basin.

Just outside of the Site boundaries, the communities of Grants (Water system no. NM3526133; Ref. 48) and Milan (Water system no. NM3525533; Ref. 49), and the Golden Acres Trailer Park (Water system no. NM3525133; Ref. 50) maintain regulated water supply systems. The Grants system serves a population of 8,892 through 3,211 service connections that are sourced from 3 wells, one of which is shown to be inactive (Ref. 48, p. 1). The wells are completed into basalt, alluvium, the San Andres Limestone, and the Glorieta Sandstone (Ref. 6, p. 14).

The Milan water system serves a population of 1,911 through 1,043 service connections that are sourced from 4 wells, one of which is shown to be inactive

(Ref. 49, p. 1); these wells are completed into the San Andres Limestone (Ref. 6, p. 14).

The Golden Acres Trailer Park system serves a population of 81 through 23 service connections that is sourced from 1 well, which currently is shown to be inactive (Ref. 50).

The Mount Taylor Millworks water system is an industrial/agricultural system that is sourced from one well. The system serves a population of 65. NMED queried for non-coliform sample results available on-line; no occurrences of analyte concentrations that exceed Federal (Ref. 9; Ref. 10) or State (Ref. 11) drinking water standards were noted among the data available (Ref. 51).

3.2.3 Ground water investigation

Ground water data from the period preceding mining inception were limited to single-event sampling of isolated windmills for general chemical characteristics, such as sulfate and TDS, and no trace element or radionuclide data are available in the San Mateo Creek (Ref. 6, p. 94) and the Arroyo del Puerto (Ref. 6, p. 95) drainages. Pre-mining alluvial ground water quality was assessed by data obtained from wells located upstream of uranium industry activities, including the Lee wells along San Mateo Creek. These data indicate that natural alluvial ground waters along San Mateo Creek trend from sodium bicarbonate water at the Lee Ranch to sodium-sulfate-bicarbonate water downstream at the Sandoval Ranch windmill. TDS concentrations increase from 540 to 650 mg/l within this 6-mile distance (Ref. 6, p. 95). Molybdenum concentrations in water from the Lee wells were consistently less than 0.010 mg/l (Ref. 6, p. 95). Uranium concentrations also were consistently less than 0.010 mg/l in these alluvial wells. At the Sandoval Ranch, pre-mining uranium concentrations were estimated to have been less than 0.030 mg/l. The EPA estimated that overall natural uranium concentrations within the Ambrosia Lake mining district approached 0.1 mg/l (Ref. 6, p. 100). Selenium concentrations were generally less than 0.005 mg/l in the Lee wells; at the downstream Sandoval Ranch windmill, EID measured a selenium concentration of 0.018 mg/l in 1980 sample, which is thought to represent an upper limit estimate of pre-mining ground water selenium concentration. Natural ground water selenium concentrations may increase downstream from the Sandoval Ranch due to contribution from selenium-enriched sediments in Poison Canyon (Ref. 6, p. 100-101).

Ground water monitoring was conducted by EID between 1977 and 1982 from stations established in San Mateo Creek and Arroyo del Puerco to characterize the quality of natural ground waters and the impacts of uranium mining to these waters—specifically to characterize hydraulic and contaminant migration relationships between surface water and shallow ground water using monitor well clusters (Ref. 6, p. 21, 26). Available data indicate the presence of little alluvial ground water along the Arroyo del Puerto under pre-mining conditions (Ref. 6, p. 95). Mine dewatering throughout the GMB transformed ephemeral streams into perennial streams, increasing recharge to underlying alluvial aquifers, which raised water levels and shallow well yields up to 50 feet between the onset of dewatering in the 1950s and the late 1970s (Ref. 6, p. 66, 77). In March and early April 1980, when mine dewatering discharge to San Mateo Creek was insignificant, occasional flows of less than 1 cubic foot per second (cfs) caused the alluvial water table to rise slowly. In contrast, streamflow increase to 3 cfs in late April, which lasted nearly two weeks, caused the water table to rise within one week, peaking in mid-May more than one foot higher than the level in mid-April (Ref. 6, p. 74). When minewater discharges were reduced, alluvial water levels monitored below the confluence of Arroyo del Puerto and San Mateo Creek declined eight feet between March 1978 and March 1982 (Ref. 6, p. 77).

Investigation of the impacts to ground water in the vicinity of the Section 35 and 36 mines indicate that alluvial ground water in this area was sourced principally from the dewatering activities (Ref. 33, p. 23).

At certain locations along San Mateo Creek, alluvial ground water chemistry more chemically resembled minewaters than natural waters. Minewater constituents that adsorb to sediments or that formed insoluble precipitates, such as radium$_{226}$, were not found in alluvial ground water in significant concentrations (Ref. 6, p. 94; Ref. 33, p. 23). Other constituents that either do not interact with stream sediments or that form insoluble precipitates, such as uranium, selenium, or molybdenum, were found in ground waters in concentrations approaching those in undiluted minewaters (Ref. 6, p. 94).

As previously noted, streamflows recharge bedrock aquifers at subcrop and outcrop areas, or where the saturated alluvium overlies permeable bedrock with downward hydraulic gradient (Section 3.2.1). At these localities, dewatering effluents also are introduced into these bedrock aquifers (Ref. 6, p. 77). Although minewater discharge to Arroyo del Puerto and San Mateo Creek are significant recharge sources to the Dakota and Morrison formations, local water level declines greater than 500 feet resulted from mine dewatering (Ref. 6, p. 77).

In general, test wells that have been affected by minewaters show concentrations of uranium, molybdenum, selenium, and gross alpha particle activity to be elevated above natural levels by 10 to 40 times (Ref. 6, p. 102). Chemical indicators in alluvial ground water to impacts from mine dewatering are inferred to include molybdenum concentrations greater than 0.03 mg/l, uranium concentrations greater than 0.03 mg/l upstream and 0.1 mg/l downstream of the confluence of San Mateo Creek with Arroyo del Puerto, selenium concentrations greater than 0.15 mg/l along San Mateo Creek upstream of the confluence, major changes in TDS concentrations and general chemistry with a distance of less than 3 miles, and significant declines in molybdenum, uranium, or selenium concentrations with increasing depth in the upper portion of the alluvial aquifer (Ref. 6, p.101). The presence of elevated selenium concentrations alone are not sufficient to demonstrate minewater effluent impacts (Ref. 6, p. 107).

Shallow ground water quality in the San Mateo Creek—Arroyo del Puerto drainage was transformed by dewatering effluents. One mile above the confluence of these watercourses, alluvial ground water at the Sandoval monitoring well cluster is indicative of sodium-sulfate-bicarbonate water chemistry, with a TDS concentration of about 650 mg/l. Downstream from the confluence, test wells produce ground water that ionically resembled Ambrosia Lake mining district minewaters (i.e., calcium-magnesium-sulfate type), with TDS over 2,100 mg/l (Ref. 6, p. 102). Mean uranium, molybdenum, and selenium concentrations at the Lee wells are below detectable concentrations of 0.005 to 0.01 mg/l; at the Sandoval well cluster, uranium and molybdenum concentrations are 10 to 20 times detectable limits, which was attributed to the effect of effluent infiltration. Below the confluence with the Arroyo del Puerto, uranium, molybdenum, and selenium concentrations were approximately 3 times higher than at the Sandoval well cluster. Uranium and molybdenum concentrations in the Otero wells are as much 7 times greater than projected natural levels in this portion of the San Mateo Creek drainage, indicating water quality degradation from minewater. Both uranium and molybdenum concentrations decrease with depth (Ref. 6, p. 105). Gross alpha particle activity also was significantly elevated along San Mateo Creek below the Lee wells, which reflects uranium concentrations almost exclusively (Ref. 6, p. 105).

Ground water restoration for the HMC site has been ongoing in 4 aquifers (i.e., Alluvial, Upper Chinle, Middle Chinle, and Lower Chinle) since 1977 (Ref. 12, p. 1.1-1). Monitoring data from 2006 indicates that concentrations of one or more site contaminants of concern exceed site ground water standards (Ref. 8), as well as Federal (Ref. 9 and 10) and State (Ref. 11) drinking water standards within each of the impacted aquifers (Ref. 12, p. 4.3-21, 4.3-39, 4.3-53, 4.3-73, 4.3-90, 4.3-107, 4.3-124, 4.3-141, 5.3-8, 5.3-12, 5.3-15, 5.3-18, 5.3-21, 5.3-24, 5.3-27, 6.3-8, 6.3-12, 6.3-15, 6.3-18, 6.3-21, 6.3-24, 6.3-27, 7.3-6, 7.3-10, 7.3-13, 7.3-16, 7.3-19). Several monitor wells within the underlying San Andres aquifer (Ref. 12, p. 8.0-4; Ref. 13), which is not addressed by the Homestake restoration (see Ref. 12, p. 1.1-1) have shown uranium concentrations exceeding Federal (Ref. 9) and State (Ref. 11) drinking water standards; most of these detections do not appear to be related to the HMC site (Ref. 14).

3.3 Soil exposure pathway

The soil exposure pathway assesses the threat to human health and the environment by direct contact with hazardous substances and areas of suspected contamination. This pathway addresses any material containing hazardous substances that is on or within 2 feet of the surface and not capped by an impermeable cover.

3.3.1 Soil exposure pathway description

An ongoing EPA risk assessment for the Homestake site will investigate the potential for contaminated soil source to impact human health through media including plant and animal uptake, as well as by direct contact (Ref. 52). The need to further characterize this pathway will be dependent upon waste characteristics at individual mine and mill sites within the Site.

3.3.2 Soil investigation results

Pond and stream sediment analytical and soils analytical data collected from the Poison Canyon Mining District are shown in Table 4. These data, in comparison to background samples collected within the same area, indicate elevated concentrations of uranium_{238}, uranium_{234}, thorium_{230}, radium_{226}, lead_{210}, vanadium, lead, and copper in one or more of these samples (Ref. 40). Selenium is locally enriched in soils and plants in the Poison Canyon area (cited in Ref. 6, p. 100).

The investigation of soil impacts from dewatering activities associated with the Section 35 and 36 mines indicate that $radium_{226}$ and uranium concentrations in soil, while decreasing with increasing depth, exceed assumed background concentrations. Exclusive of arsenic, total metals concentrations are below New Mexico Environment Department (NMED) Soil Screening Levels, and leachable metals concentrations, excluding selenium, and leachable major ions and TDS are below New Mexico Water Quality Control Commission (WQCC) standards (Ref. 33, p. 7-8).

3.4 Surface water pathway

The surface water pathway assesses the threat to human health and the environment by determining whether hazardous substances are likely to have been released to surface water; and whether any receptors (intakes supplying drinking water, fisheries, sensitive environments) are likely to be exposed to a hazardous substance as a result of a release.

3.4.1 Hydrology

Most streams are ephemeral within the GMB. Peak runoff from heavy late-summer thunderstorms and lesser flows from snow melt in late winter and early spring carry high sediment loads (Ref. 6, p. 13). San Mateo Creek has flowed continuously since construction of San Mateo Reservoir near the community of San Mateo; however this flow usually is ephemeral within 1 mile below San Mateo (Ref. 6, p. 13). Average stream bed loss along San Mateo Creek is approximately 0.72 cubic meters per minute per kilometer (Ref. 6, p. 72). Infiltration rate in the Ambrosia Lake mining district was calculated to be 7.54 cubic meters per minute (Ref. 6, p. 74).

3.4.2 Surface water use

Ephemeral perennial streamflows that were created from mine dewatering were important livestock water supplies (Ref. 6, p. 14). Surface water in the GMB, both from natural or mining-impacted sources, was used for livestock watering. Only artificially-maintained perennial streams were used for irrigation. No domestic use of surface water has been documented (Ref. 6, p. 111).

3.4.3 Surface water investigation

Natural runoff has average suspended sediment concentrations greater than 30,000 mg/l. Flow within San Mateo Creek typically has suspended sediment concentrations less than 400 mg/l. TDS concentrations in flow within Arroyo del Puerto that was influenced by mine discharge were 1,500 to 2,000 mg/l; occasionally natural waters diluted these concentrations to less than 1,000 mg/l (Ref. 6, p. 84).

In natural runoff, contaminants are generally associated with suspended sediment and precipitates (Ref. 6, p. 87). Natural runoff has median concentrations of total molybdenum and selenium of less than 0.01 and 0.03 mg/l respectively (Ref. 6, p. 87). Median total barium concentrations in natural runoff is 7.7 mg/l (Ref. 6, p. 88). As much of 99% of the gross alpha and gross beta particle activities in natural runoff are associated with precipitates and suspended sediment. Dissolved gross alpha levels are generally less than 20 picocuries per liter ("pCi/L"), with dissolved uranium accounting for more than 80 percent. Total $radium_{226}$ concentration in natural runoff often exceeds 15 pCi/L, but usually has less than 2 pCi/L of dissolved $radium_{226}$. Natural runoff typically has concentrations of total $lead_{210}$ and $polonium_{210}$ between 40 and 90 pCi/L respectively (Ref. 6, p. 90).

Surface water monitoring was conducted by EID between 1977 and 1982 from stations established in San Mateo Creek and Arroyo del Puerto to characterize the quality of natural surface waters and the impacts of uranium mining to these waters—specifically to characterize hydraulic and contaminant migration relationships between surface water and shallow ground water. Monitoring locations included flow from both uranium mine dewatering effluents and natural perennial flow (Ref. 6, p. 21). Additionally, single-stage samplers were installed within ephemeral watercourses above and below mine waste piles to characterize runoff; additionally grab samples collected during runoff events above and below waste piles (Ref. 6, p. 32).

EID investigators concluded that TDS concentrations in perennial stream flows throughout the GMB varied between less than 200 to greater than 1,500 mg/l, with the lowest TDS values found in the perennial flow of San Mateo Creek (Ref. 6, p. 43-44). Dissolved trace element and radionuclide concentrations in both perennial and ephemeral flows throughout the GMB are very low, due to the low solubility of these materials and the prevailing neutral to slightly alkaline nature of the flows (Ref. 6, p. 45). Suspended sediment concentration in the San Mateo perennial flow had a log mean concentration of 10 mg/l, while ephemeral flow in the same streamcourse had a log mean concentration of 8,100 mg/l (Ref. 6, p. 47). Total trace element and radionuclide concentrations in natural runoff generally were dependent upon sample sediment amounts. Molybdenum was virtually absent from runoff (Ref. 6, p. 48). In turbid waters, gross alpha particle activity among 5 samples ranged from 33 pCi/L to 2,100 pCi/L, with a median concentration of 1,200 pCi/L. Gross beta particle activity among 4 samples ranged from 546 pCi/L to 2,000 pCi/L, with a median concentration of 1,060 pCi/L (Ref. 6, p. 48). The majority of $radium_{226}$ and $lead_{210}$ concentrations found in turbid water samples were bound to sediments (Ref. 6, p. 51). Maximum gross alpha particle activity exceeded maximum natural runoff activity by 200 times. Maximum levels of natural uranium and $radium_{226}$, which are 2 major alpha particle emitters, exceed natural maximum runoff levels by over 100 times. Gross beta particle activity, especially from $lead_{210}$, also far exceed natural runoff levels (Ref. 6, p. 57).

As noted previously (Section 3.1), runoff sampling below uranium mine waste piles indicated that sediment concentrations were comparable to natural sediment concentrations.

3.5 Air pathway

The air pathway assesses the threat to human health and the environment by determining whether hazardous substances are likely to have been released to the air; and whether any receptors (human population and sensitive environments) are likely to be exposed to hazardous substances as a result of a release. The need to characterize this pathway will be dependent upon waste characteristics at, and population densities near, individual mine and mill sites within the Site.

4.0 Summary and conclusions

NMED has identified 85 formerly-producing uranium minesites and 4 uranium millsites (Ref. 7) within the approximately 321 square mile (Ref. 3) San Mateo Creek basin (Ref. 3, 4) for investigation of potential sources of background ground water contaminant concentrations that exceed Federal (Ref. 9 and 10) and State (Ref. 11) drinking water standards. Population density within the area of the Site is between 6 (Ref. 19, p. 2) and 13 people (Ref. 19, p. 1) people per square mile. The communities of Grants and Milan, which are located just outside of the boundaries of the Site, have populations of 8,806 (Ref. 21) and 1,891 (Ref. 22) people respectively. Therefore, the total potentially-impacted population within a 4-mile radius of the Site boundaries is inferred to be between 10,000 and 30,000 people.

Analyses of waste rock samples from the Poison Canyon Mining District showed that contaminant concentrations are elevated relative to background (Ref. 40). EID analyzed composite minewaste samples from within the Site to determine contaminant leachability (Ref. 6, p. 34-35); these tests indicated that these materials had relatively low potential for leaching and ground water degradation (Ref. 6, p. 57). Nevertheless, the EID investigation also noted that the contaminant concentrations in runoff from mine waste exceeded natural concentrations (Ref. 6, p. 54, 55, 57).

Water produced from mine dewatering contained elevated contaminant concentrations (Ref. 6, p. 80, 84), and produced perennial flows in San Mateo Creek and Arroyo del Puerto (Ref. 6, p. 66, 68, 72, 77). These flows increased recharge to alluvial aquifers in the Ambrosia Lake mining district. Mine discharge elevated TDS concentrations in Arroyo del Puerto surface water flows (Ref. 6, p. 84). Maximum levels of natural uranium and $radium_{226}$, as well as gross alpha and beta particle activity, exceeded natural runoff levels within the GMB (Ref. 6, p. 57). Although the effluents were treated to reduce solids and radium concentrations (Ref. 6, p. 20-21), some contaminant concentrations were found to be higher than was found in natural runoff (Ref. 6, p. 87, 88, 90). EID collected effluent samples with elevated concentrations of $radium_{266}$, $lead_{210}$, and $polonium_{210}$ that were attributed to episodes of ineffective minewater treatment (Ref. 6, p. 90). Some contaminants were observed to precipitate or bind to stream sediments where available, but would move downstream during flow events; in relatively sediment-free stream channels, contaminant concentrations were not readily attenuated (Ref. 6, p. 90-92).

Little data are available to determine ground water quality before the inception of mining (Ref. 6, p. 94, 95). Mine dewatering increased recharge to, and water levels in, alluvial aquifers (Ref. 6, p. 21, 26, 66, 74, 77; Ref. 33, p. 23). Mine dewatering changed hydrologic conditions throughout the Site (Ref. 6, p. 13; Ref. 42, p. 3). Alluvial ground water was found to have some geochemical similarities to minewaters (Ref. 6, p. 94, 101, 102, 105, 107); natural attenuation was found to moderate some geochemical effects (Ref. 6, p. 94; Ref. 33, p. 23).

Bedrock ground water levels were greatly reduced from the dewatering activities (Ref. 6, p. 13; Ref. 42, p. 3). However, where bedrock aquifers subcrop alluvial aquifers or outcrop in streamcourses, the dewatering effluents recharged these aquifers (Ref. 6, p. 77).

Within the Site boundary, ground water supplies water systems for the community of San Mateo (Ref. 20), and the Tri-State Generating Station (Ref. 43). The community of Haystack also uses ground water (Ref. 41). Immediately outside of the Site boundary are water systems for the communities of Grants (Ref. 48) and Milan (Ref. 49), as well as the Golden Acres Trailer Park (Ref. 50). Another water system in the area is registered to the Mount Taylor Millworks (Ref. 51). Available ground water usage is summarized in Table 5.

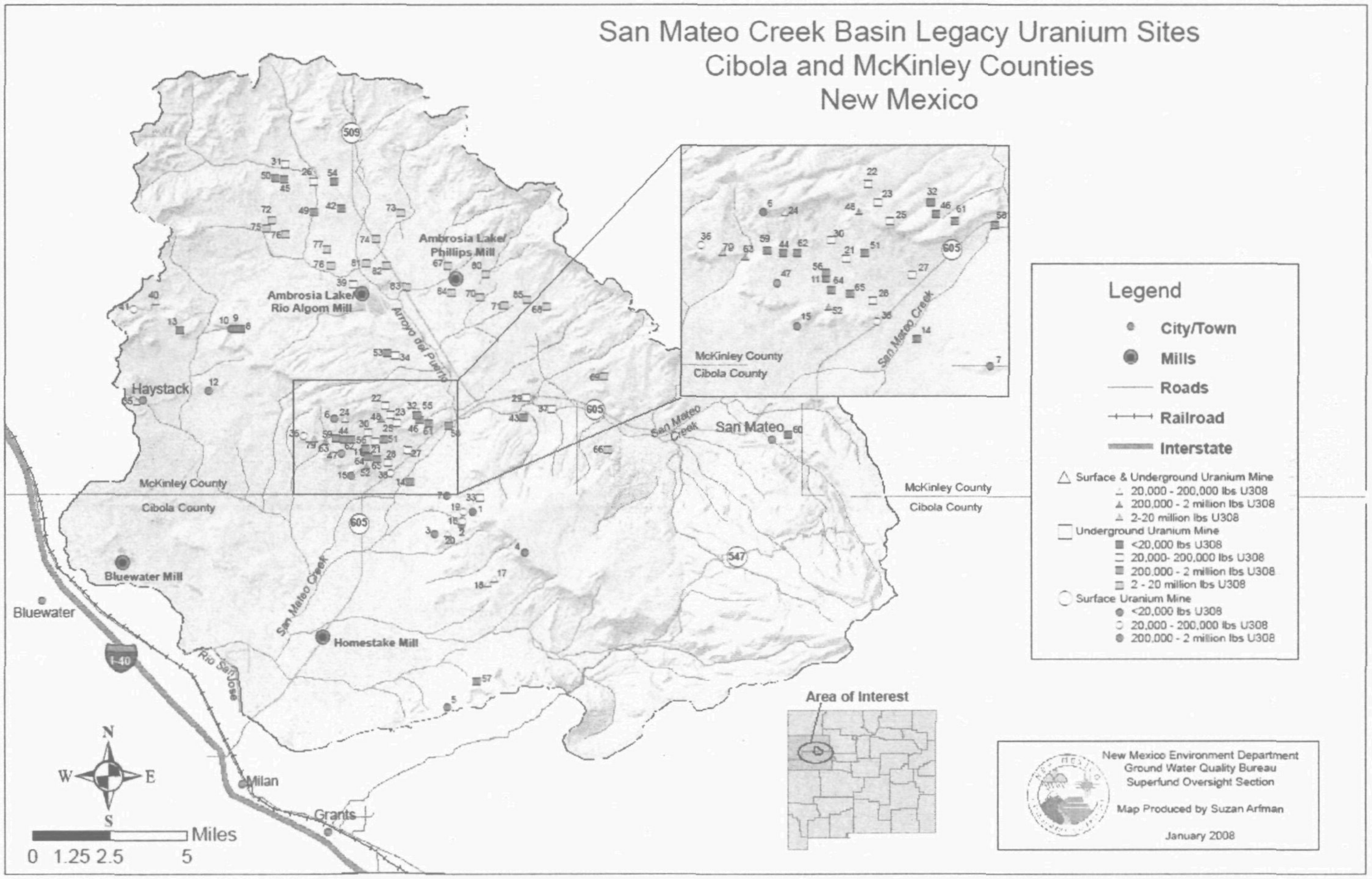
Sludges produced in ponds, in which mine effluents were treated, had some elevated contaminant concentrations (Ref. 6, p. 20-21, 80, 82).

Soil samples from the Poison Canyon Mining District show elevated contaminant concentrations (Ref. 40), as do samples taken from soils impacted by Section 35 and 36 mine dewatering (Ref. 33, p. 7-8). Soil samples from areas impacted by dewatering of the Section 35 and 36 mines indicate $radium_{226}$ and uranium concentrations in soil exceed assumed background concentrations. Exclusive of arsenic, total metals concentrations are below New Mexico Environment Department (NMED) Soil Screening Levels, and leachable metals concentrations, excluding selenium, and leachable major ions and TDS are below New Mexico Water Quality Control Commission (WQCC) standards (Ref. 33, p. 7-8).

The air pathway was not evaluated for this study, but should be studied during recommended further CERCLA investigation of this Site.

5.0 Figures

Figure 1: Mines and mill locations
Ref. 3, 4, 5, 7, 53, 54



Notes:
Symbology for mines is derived from Ref. 7 according to the following schema:

- Surface and underground, underground, and surface uranium mine categorization (Ref. 55).
- Production categorization (Ref. 56).

See Table 1 for mine information.

Figure 2: Bedrock geology of the San Mateo Creek drainage

References as for Figure 1 plus Ref. 57

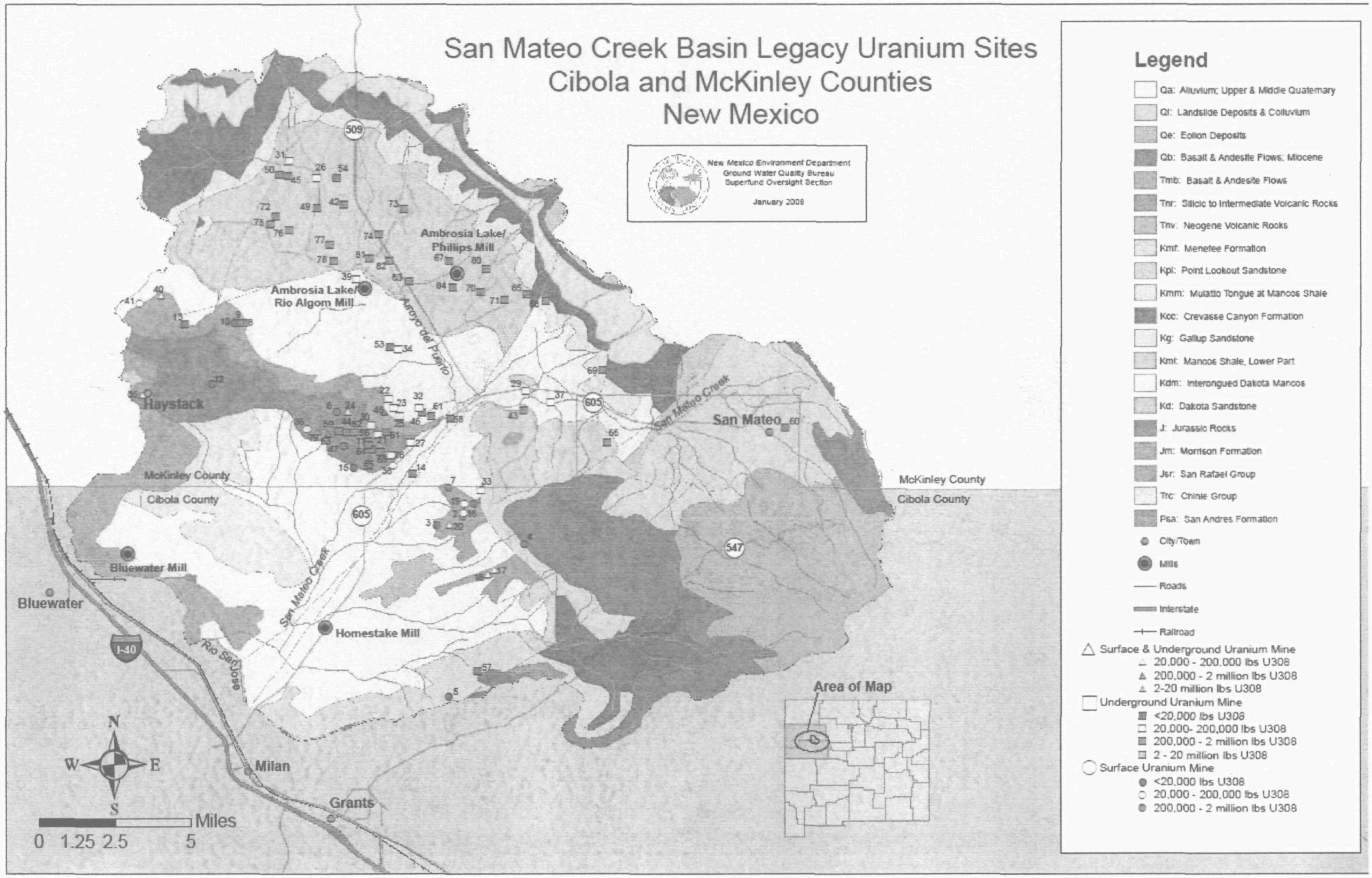


Figure 3: Surficial landownership within the San Mateo Creek drainage basin

References as for Figure 1 plus Ref. 29

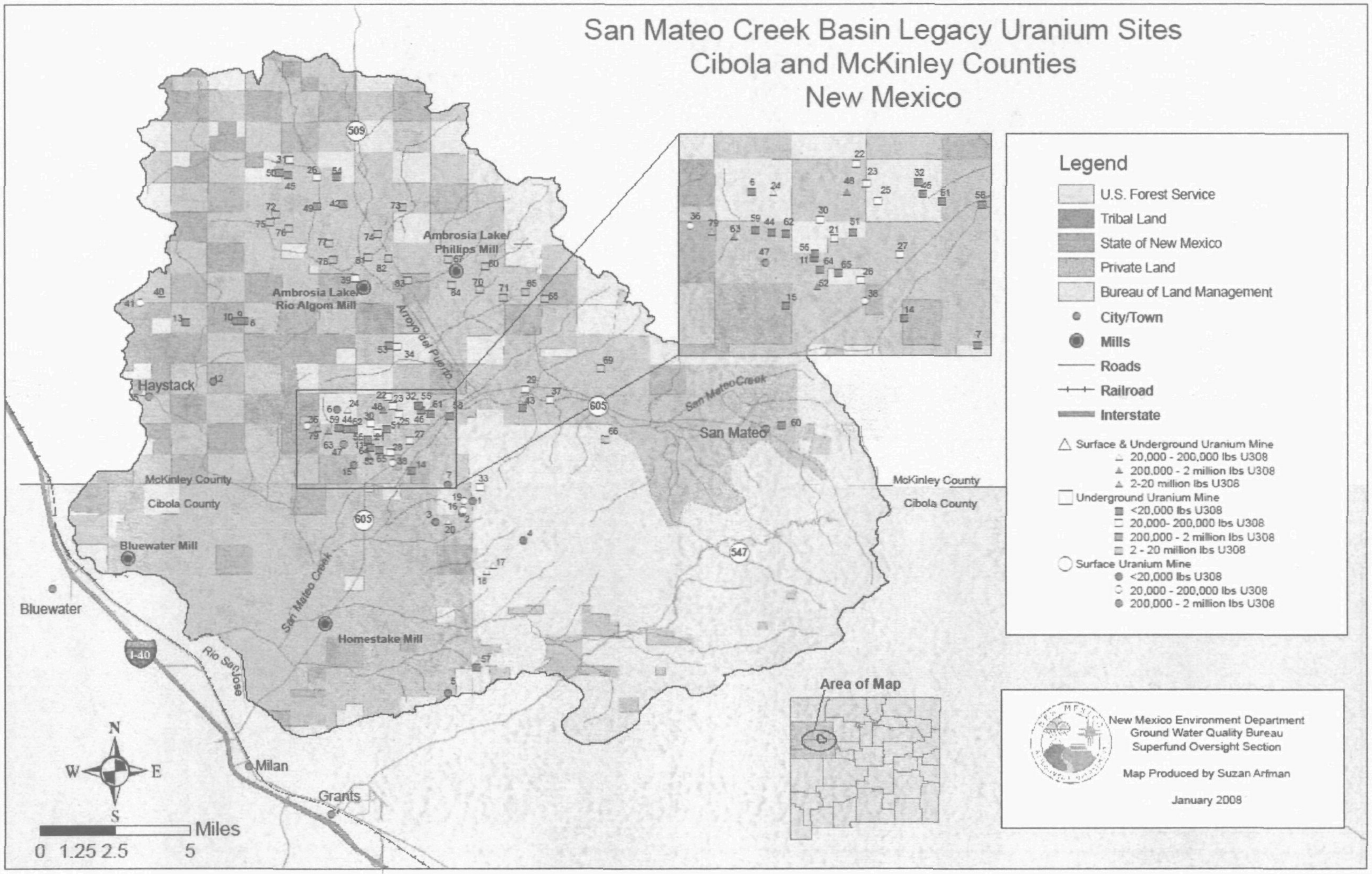
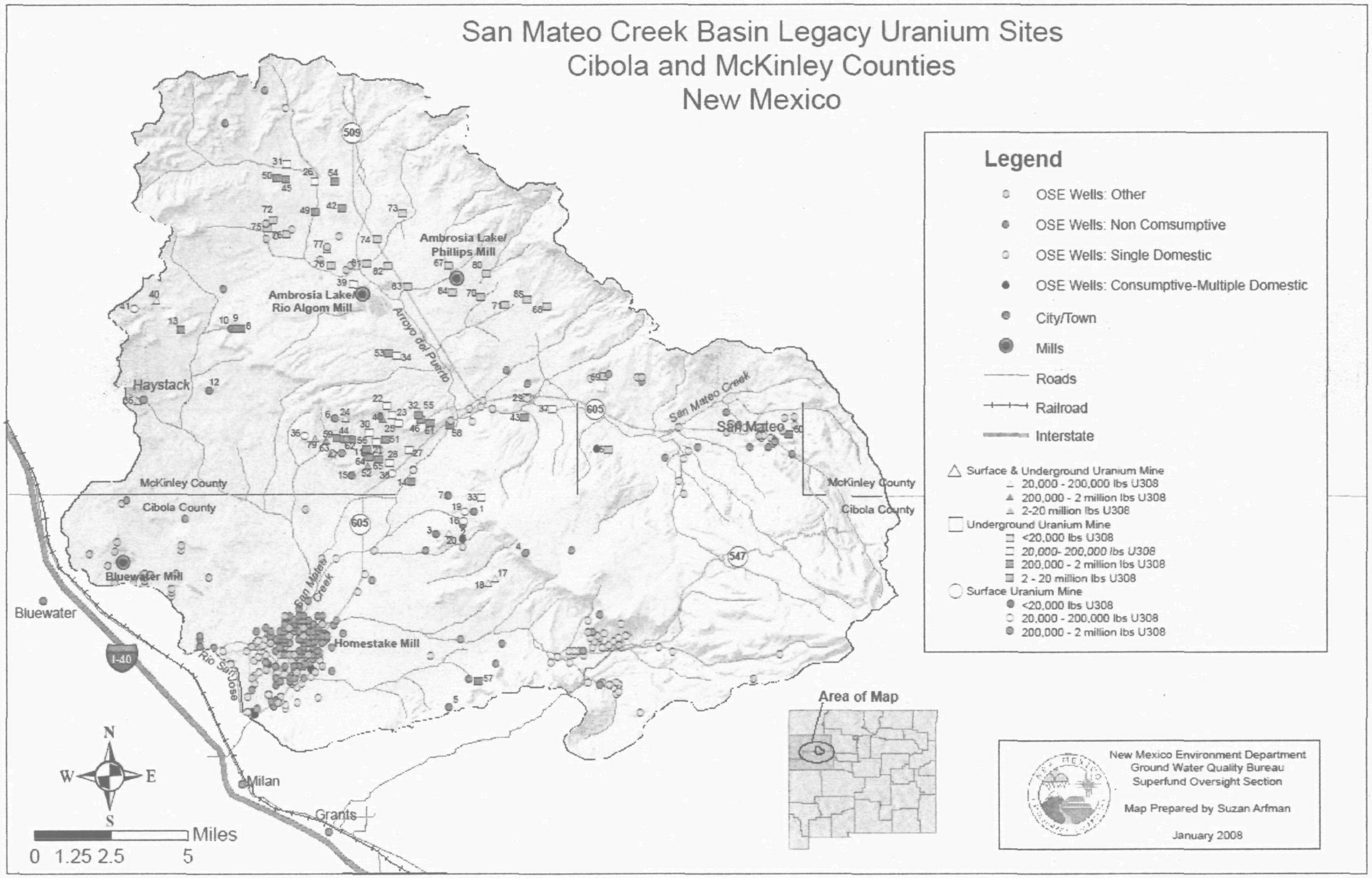


Figure 4: Wells within the San Mateo Creek basin that are registered with the New Mexico Office of the State Engineer

References as for Figure 1 plus Ref. 58 (see notes)



Notes to Figure 4:
Wells data from Ref. 58, and are summarized by use categories (Ref. 59, 60) in this figure as follows:

- OSE wells: Other = includes DEW, EXP, MIN, MON, NOT, OBS, PRO, and PUB categories and entries with no category (i.e., blanks)
- OSE wells: Non consumptive = includes IND, IRR, SAN, STK categories
- OSE wells: Single domestic = includes DOM category
- OSE wells: Consumptive—multiple domestic = includes MUL, MOB, MDW categories

6.0 Tables

Table 1: Mines within the Site boundary

All data excerpted from Ref. 7

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
1	Christmas Day	Phil, Christmas Day No. 1-4		Bureau of Land Management	surface	1954	1956	a		dump 700 cps; workings 500-700 cps	
2	Gay Eagle				surface	1952	1965	a			
3	Last Chance	Bottoms		Bureau of Land Management	surface	1951	1956	a			
4	Taffy	Bonanza No. 1, Trustco Corp	U. S. Forest Service	U. S. Forest Service	surface	1961	1961	a		background 50 cps; high 4,500 cps	
5	Tom	Tom No. 13, Tom Group, Vanadium	private or Bureau of Land Management	private or Bureau of Land Management	surface	1954	1955	a			
6	Bobcat		Bureau of Land Management	Bureau of Land Management	surface	1956	1956	a	4.80	debris	
7	Charlotte	Section 33, Farris	Sonny & Isabel Marquez	Newmont Mining Co.	surface	1958	1958	a		background 50 cps; face cut 125 cps	
8	Pat	Dakota Mine, Gossett, Black Rock, Section 4, Martinez Lease	Navajo Allotee	Navajo Allotee	underground	1952	1963	a	5.59	background 90-130 cps; adits 3,900 cps; stope 3,500 cps	
9	Dakota		Navajo Allotee	Navajo Allotee	underground	1952	1963	a-f	2.36	background 50 cps; high 500 cps	
10	Junior	Pat, Section 4	Navajo Allotee	Navajo Allotee	surface	1953	1953	a-f	7.64	background 70 cps; max 200 cps	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
11	Piedra Trieste	Section 30, Piedra Lisa	Bureau of Land Management	Bureau of Land Management	underground	1979	1981	a	15.00		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; adit timbering removed, incline pit backfilled with mine waste, 2 air shafts backfilled with gravel
12	Red Point	R. M. Shaw	State Land Office	State Land Office	surface	1952	1955	a	1.83	background 50 cps; pits 3,800 cps; dumps 1,500 cps	
13	Section 5	Westvaco, Febo, Los Tres Mosqueteros	Cerrillos Land Company	Newmont Mining Co.	underground	1958	1958	a	2.89	background 50 cps; adit 800 cps	
14	Moe No. 4	Section 32	State Land Office	State Land Office	underground	1961	1963	a		background 20-30 cps, dump high 2,200 cps	
15	Red Bluff No. 1	Rimrock, Homer Scriven, Section 36	State Land Office	State Land Office	surface	1952	1964	a	7.51	pit 1,100 cps	
16	Black Hawk, Bunney, Red Bluff	Section 4, Bunney Group	Bureau of Land Management, private	Bureau of Land Management	surface	1952	1967	b			
17	La Jara	Zia, La Jara No. 1-9	U. S. Forest Service	U. S. Forest Service	surface, underground	1952	1960	b	4.00	background 70 cps; open pit 150-200 cps	
18	Zia		U. S. Forest Service	U. S. Forest Service	underground, surface	1952	1958	b-f	4.00	background 70 cps; adit (S) 1,700 cps; waste pile 600 cps	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
19	Red Bluff No. 1, 2, 3, 4, 5,	Elkins and Jones			surface	1952	1976	b		max 1,000 cps	
20	Section 9	Mark Elkins, Anaconda			surface, underground	1950	1962	b		adit 10,000 cps	
21	Barbara J No. 1	Whitecap, Dalco, Barbara Jean No. 1	Bureau of Land Management	Bureau of Land Management	room and pillar	1956	1968	b	7.00		1993 Mar/Apr: Contractor: Khani Co., headframe demolished, shaft plugged with 3 ft bentonite plug and backfilled with waste from Barbara J No. 3 site; 1980: Anderson observed shaft backfilled & site regraded
22	Beacon Hill Gossett	Malpais No. 10 & 14; Section 18, Moe No. 3	Bureau of Land Management	Bureau of Land Management	underground, open stope	1956	1978	b	15.00		1993 Mar/Apr: Contractor: Khani Co.; loading structure & powder magazine demolished, decline adits plugged with mine waste, 2 ventilation shafts backfilled, diversion ditches constructed on uphill slopes
23	Beacon Hill	Mesa Top, Malpais, East Malpais, Davenport, Beacon Hill No. 18-23	Bureau of Land Management	Bureau of Land Management	underground	1956	1967	b-f			1993 Mar/Apr: Contractor: Khani Co.; shaft backfilled

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
24	Blue Peak	Garcia No. 1-5, Red Top No. 1-10, Section 24	Bureau of Land Management	Bureau of Land Management	underground, stripping	1951	1965	b	6.34		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; timber loadout dismantled, backfilled 5 adits with on-site mine waste
25	Davenport	Moe No. 2, Davenport Incline	Bureau of Land Management		underground	1957	1966	b	6.00		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; powder box dismantled, decline and adit backfilled with mine waste from Davenport and Mesa Top Mines
26	Dysart No. 2	Section 11, SE Shaft	? Homestake Mining Co.	? Homestake Mining Co.	underground	1959	1983	b		background 75 cps; main dump intersecting road 1,500 cps; small dump 1,100 cps	
27	Faith	Section 29, Westvaco	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1958	1964	b	1.00		1986 shafts backfilled, surfaces recountoured, reseeded
28	Flat Top	Fife and Bailey, Vilatie Hyde	Bureau of Land Management	Bureau of Land Management	underground	1955	1966	b	10.00		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; timber/debris removed from adit, chute removed, 5 subsidence areas backfilled with mine waste & graded, adit backfilled with mine waste, 3 vent holes backfilled with gravel

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
29	Hogan	Lucky Dooley, Fence, Plain		Bureau of Land Management	underground	1959	1962	b		background 50cps; shaft 450cps; dump 200-400 cps	shaft cross-timbered and 10-15 ft concrete plug poured
30	Hope	Section 19	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1977	1981	b	10.00		1991/2 Cerrillos Land Co. regraded waste rock, shaft backfilled, revegetated
31	Mary No. 1	Section 11 NWQ, Dysart No. 3	??? Homestake Mining CO.	??? Homestake Mining Co.	underground	1959	1965	b	33.88	shaft 400-600 cps high 1,200 cps; dump 600-1,500 cps	
32	Mesa Top	Mesa Top No. 5, Malpais, Davenport, Malpais No. 13, Beacon Hill No. 18-20	Bureau of Land Management	Bureau of Land Management	underground, open stope	1954	1958	b	10.00		
33	Vallejo	Double Jerry, Section 34, Farris No. 1	U. S. Forest Service	U. S. Forest Service	underground	1957	1963	b	2.00	portal 350-600 cps	
34	Spencer	Section 8, Centennial, State No. 1-27 claims	Bureau of Land Management	Bureau of Land Management	underground	1958	1980	b		background 70cps; dump area 300-600 cps	1997 Nov: AML installed 350 ft fencing
35	Section 18	Williams and Thompson, Brown Vandever, Federal Mine	Navajo Allotee	Navajo Allotee	underground, surface	1952	1966	b	12.68	stockpile 1,000 cps; stope 150 cps	
36	Haystack Section 23	Sec 23 & 26 Open Pit	Navajo Tribal Fee (Sec 23), Navajo Allotee (Sec 26)	Navajo Tribal Fee (Sec 23), Navajo Allotee (Sec 26)	surface	1957	1966	b	17.61	face cuts 1,500 cps; mineralized zones 5,000 cps	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
37	Chill Willis	Rialto, Section 13, Section 24	Marquez Ranch	Conoco	underground	1960	1963	b		background 50 cps; dump 600 cps with 1,500 cps1500 cps, stock pile 600-1,000 cps	
38	Haystack Section 31	Santa Fe Railroad, Henri Dole, Section 31 NWQ	Isabella O. Marquez Trust	Newmont Mining Corp.	surface	1953	1975	b		background 20-30 cps, dump 150 cps	1987 pits backfilled; 1994 fall Santa Fe Pacific Gold reclaimed & reseeded, debris removed; 1995 trespass dumping & minor erosion observed
39	United Western	J and M, Section 36, Lease 60-167, VCA mine	State Land Office	State Land Office	underground	1957	1960	b		dump 700-900 cps	1980 Anderson: shaft backfilled, buildings removed; equipment salvaged; Per AML 1989 in Grants Phase 1 recon: no threat, reclaimed
40	Febco	Silver Spur No. 1-5, Berryhill-Elkins, Small Stake	Berryhill Family	Berryhill Family	surface, underground	1952	1966	b	4.16	portals 350 cps; tailings dumps 800-1,200 cps	
41	Silver Spur	Febco, Silver Spur No. 5	Berryhill Family	Berryhill Family	surface	1955	1958	b-f	3.31	pits 1,800-2,000 cps; dump 900 cps	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
42	Section 13	Westwater Corp.	Jerry & Luann Elkins	Newmont Mining Corp.	underground	1979	1981	c	20.00		1991 Aug buildings removed and buried on site; boreholes backfilled and sealed with reinforced concrete cap; shaft backfilled and capped with reinforced concrete cap; 1992 May-June earthwork to reconfigure/cover waste piles; placement of topsoil; 1992 Ju
43	Marquez	Marcus, Calumet	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1958	1971	c		dump 800-2,500 cps; stockpile 10,000 cps; high readings on streambed road	1987 Santa Fe Pacific Gold declined adit shaft backfilled; structures removes; regraded; 12in topsoil depth - all sand
44	Divide	Section 25	Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp.	underground	1952	1973	c-f	0.58	background 20-30 cps; outcrop 300-350cps	
45	Dysart No. 1	Rio de Oro, Section 11	unknown	unknown	underground	1956	1983	c	58.55	background 70 cps; shaft 700-1,000 cps, dump/stockpile 400-700 cps	
46	Dog	Dog Incline, Flea Incline; Dog-Flea, B-G Group, BG Group, Section 20	*Bureau of Land Management*	*Bureau of Land Management*	underground	1957	1975	c	30.00	dumps 350-750 cps; waste *washing into* arroyo	

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
47	Section 25 SEQ	Desiderio, Amiran, Operation Haystack, Rimrock No. 1	Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp.	surface	1952	1981	c	63.56	background 20-30 cps; waste 900 cps; pits 2,000-3,300 cps	
48	Poison Canyon	Moe No. 1	Isabella O. Marquez Trust	Newmont Mining Corp.	surface, underground	1952	1978	c	30.00		1987 shafts backfilled; 1993 & 1994 additional reclamation activities; 2000 erosional rilling reclaimed
49	Bucky	Section 14, Jeep No. 1-6, Buckey, Buckly	Cobb Resources	Bureau of Land Management	underground	1957	1982	c	27.43		
50	Section 10	Kermac, Regomex, Ambromex, Buffalo	Cobb Resources, ??? Bureau of Land Management	Cobb Resources, ??? Bureau of Land Management	underground	1957	1981	c	16.48	shaft 400 cps with high 900cps; dump 400-700 cps; ventilation shaft air >6,000 cps	by 1980 shaft secured with wire mesh fence
51	Barbara J No. 3	Fife and Bailey, Barbara Jean No. 3	Bureau of Land Management	Bureau of Land Management	underground	1959	1980	c	5.00		1980: shaft covered by Todilto; 1993 Mar/Apr: Contractor: Khani Co.; casing, water tank, timbering, etc. removed, 1 shafts closed with 2-ft bentonite plug and backfilled with riprap, 1 ventilation shaft backfilled with riprap, vent holes backfilled

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
52	Roundy - Manol	Manol, F. Manol, Roundy Lease, Rimrock No. 3, Section 30			surface, underground	1952	1981	c	6.30	background 20-30 cps, dumps 500-600 cps with 1,000-2,200 cps high	
53	Isabella	Section 7	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1959	1980	c	2.00	background 80 cops; shaft area outside fence 350 cps; waste dumps 1,000-1,7000 cps with 2,000 spikes; high readin	
54	Section 12	Dysart Group, Tana and Alto	Bureau of Land Management	Cobb Resources	underground	1961	1982	c			
55	Malpais	Malpais No. 13, Dog No. 10, East Malpais, Malpais raise, Mesa Top	Bureau of Land Management	Bureau of Land Management	underground	1958	1961	c	8.00		1993 Mar/Apr: Contractor: Khani Co.; casing, water tank, timbering, etc. removed, 1 shafts closed with 2-ft bentonite plug and backfilled with riprap, 1 ventilation shaft backfilled with riprap, vent holes backfilled
56	Barbara J No. 2	Whitecap, Dalco No. 1, Barbara Jean No. 2	Bureau of Land Management	Bureau of Land Management	underground	1957	1968	c	8.00		1993 Mar/Apr: Contractor: Khani Co.; headframe removed, shaft backfilled with mine waste (shaft collapsed during construction)

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
57	F-33	Section 33, Anaconda, Forest Group, Head & Keely	Atlantic Richfield Co.	Atlantic Richfield Co.	underground	1954	1977	c	39.00		1970s surface buildings removed; 6/17/1994 reclamation completed; reclamation included permanent closure of portals Nos. 1, 2, 4, 5 and vent raise (portal No. 3 never developed), mine waste backfilled into tunnels and portals; slopes 3h:1v or less, 12 in
58	Doris	Section 21, Doris No. 1, Little Doris; Doris decline, Flea-Doris extension,	Isabella O. Marquez Trust	Newmont Mining Corp.	underground	1958	1981	c	10.00		1991/1992 Cerrillos Land Co. both declines sealed, erosion control features, debris removed, revegetated, waste rock regraded
59	Section 25 shaft		Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp.	underground	1963	1967	c-f	18.58	background 20-30 cps; dumps 3200 cps	
60	Mount Taylor	Gulf, Chevron	Rio Grande Resources, Inc.	Rio Grande Resources, Inc.	underground	1980	1990	c	66.00		
61	Flea	Flea-Doris Extension	Bureau of Land Management (Sec 20), State Land Office (Sec 16), private (Sec	Bureau of Land Management (Sec 20), State Land Office (Sec 16), private (Sec	underground	1957	1980	c-f	20.00		1993 Mar/Apr: Contractor: Khani Co.; 2 adits reclaimed: removed wire mesh and tin cloures, removed timbering, backfilled with mine waste, 30-mil PBC cover installed on opening, 12" topsoil, diversion ditches constructed on uphill slopes

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
62	Section 25 Decline	Tag claims, Red Rock	Elkins Real Estate, Berryhill Ranch, Ltd. (Sec 25), Bureau of Land Managemet	Newmont Mining Corp. (Sec 25), Bureau of Land Managemetn (Sec 24)	underground	0	0	c-f	2.89	background 20-30 cps; max 400cps	
63	Section 25 Open Pit	Desiderio, Amiran	Elkins Real Estate, Berryhill Ranch, Ltd.	Newmont Mining Corp.	underground, surface	1952	1981	c-f	21.69	background 20-30 cps; waste 900 cps; pits 2,000-3,300 cps	1980s: Amiran/Reserve backfilled features after lease expired; 1993 Santa Fe Pacific reclaimed & reseeded; 1994: additional reclamation; debris removed; rainwater impoundment for livestock; 12" soil depth
64	Roundy Strip	Rimrock No. 1, Manol, Section 30, H-H-50, Mano No. 1, Golden P. Roundy			underground	1952	1971	c-f		pits 300-600 cps	
65	T-20	T-9 orebody, Rimrock No. 2, T-20 shaft, Q-32	Bureau of Land Management	Bureau of Land Management	underground	1955	1968	c-f	5.00		1990 Oct/Nov: Contractor: Romero Excavation & Trucking; shaft collar and grating removed, 2 subsidence areas backfilled with mine waste, 5 vent holes backfilled with gravel, shaft backfilled with waste material, 1 ft topsoil, seeded

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
66	San Mateo	Section 30, Rare Metals	U. S. Forest Service	U. S. Forest Service	underground	1959	1971	d		surface & groundwater contamination ; waste dumps 8-25uR/hr; settling basins 100-450 uR/hr	1980s Homestake backfilled main shaft with mine water materials
67	Ann Lee	Phillips No. 1, Section 28, Spider Rock	United Nuclear Corp.	Hecla Mining	underground	1958	1982	d	0.10		portion of mine included in Phillips UMTRA Title I Site; 1994 shaft backfilled with mill/mine waste & capped with 4ft thick, 20 sq ft concrete slab; barbed wire fence; 3-ft topsoil cover, seeded
68	Cliffside	Section 36, Section 1	State Land Office (Sec 36), Isabella O. Marquez Trust (Sec 1)	State Land Office (Sec 36), Hecla Mining & Newmont Mining Corp. (Sec 1)	underground	1960	1988	d			1990 Quivira reclaimed per SLO specs ; 3-cased vent holes remain on site as monitoring wells
69	Johnny M	Ranchers	John E. Motica, Fernandez Co.	Newmont Mining Corp.	underground	1976	1982	d			1982: mined-out areas backfilled with tailings, shaft sealed with concrete plug, portal sealed with concrete plug; 1993: Fed Reg Docket No. 40-8914 released 5/13/1993
70	John Bully	John Bully shaft, Sandstone	United Nuclear Corp	Hecla Mining	underground	1959	1980	d-f			

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
71	Sandstone	Section 34, John Billy shaft	United Nuclear Corp	Hecla Mining	underground	1959	1980	d	8.00		1980s: headframe removed; 1994 fall: barbed-wire fence; shafts backfilled and topped with concrete cap; 2ft soil depth; seeded
72	Section 15	Homestake Sapin Mine No. 15	Jerry & Luann Elkins	Newmont Mining Corp.	underground	1958	1981	d	30.00		1991 Aug-Sept: buildings demolished & buried on site, shaft & decline backfilled & capped with reinforced concrete; boreholes backfilled & capped; ponds/containment berms flattened; 1992 May-June: earthwork to reconfigure/cover waste piles; placement of
73	Section 17	Jerry Wayne No.. 1-36, Carter, Section 18, Shale No. 1-36	Rio Algom (Sec 17,18), Bureau of Land Management (Sec 20)	Rio Algom (Sec 17,18), Bureau of Land Management (Sec 20)	underground	1960	2002	d	22.00		1994 June Quivira reclaimed
74	Section 19	Section 20	Rio Algom (Sec 19), Bureau of Land Management (Sec 20)	Rio Algom (Sec 19), Bureau of Land Management (Sec 20)	underground	1962	2002	d	19.00		1994 June Quivira reclaimed
75	Section 22		Rio Algom	Rio Algom	underground	1958	2002	d	37.00		1994 June Quivira reclaimed

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
76	Section 23		Rio Algom	Newmont Mining Corp.	underground	1959	1989	d	100.00		1991 August: buildings, headframe, hoist equipment, IX plant & trash removed, building material buried on site, IX plant disposed at Grants mill site, shaft backfilled & sealed with reinforced concrete shaft, boreholes backfilled and capped with concrete
77	Section 24	Section 24 and 26, Mine No. 24	Rio Algom (Sec 24), Bureau of Land Management (Sec 26)	Rio Algom (Sec 24), Bureau of Land Management (Sec 26)	underground	1959	2002	d	26.00		1994 June Quivira reclaimed
78	Section 25	Homestake Sapin No. 25	Homestake Mining Co., Elbert Roundy Ranch	Newmont Mining Corp.	underground	1958	1990	d	115.00		1991 August: buildings, headframe, hoist equipment, IX plant & trash removed; building material buried on site, IX plant disposed at Grants mill site, shaft backfilled & sealed with reinforced concrete, boreholes backfilled & capped with concrete, inject
79	Section 26	Hanosh, Indian Allotment, Desidero	Navajo Allotee	Navajo Allotee	surface, underground	1952	1980	d	15.24	open pit 1,800 cps	
80	Section 27	United Nuclear	Schmitt Ranches	Hecla Mining	underground	1967	1981	d	15.00		

Fig. 1 index no.	MINE NAME	ALIASES	SURFACE OWNERSHIP	MINERAL OWNERSHIP	MINING METHOD	1st YEAR	LAST YEAR	PRODUCTION	DISTURBED	RADIATION	RECLAMATION
81	Section 30 West		Rio Algom	Rio Algom	underground	1970	2002	d	26.00		1994 June Quivira reclaimed
82	Section 30	Carter 1-36, Section 29, Mining Unit 30	Rio Algom	Rio Algom	underground	1958	2002	d	44.00		1994 June Quivira reclaimed
83	Section 32	United Western, UP-HP, Section 29, Section 31	State Land Office (Sec 32), private	State Land Office (Sec 32), private	underground	1958	1982	d	60.00		1991 Aug-Sept: buildings removed & buried on site, boreholes backfilled & sealed with reinforced concrete, shaft backfilled & capped with reinforced concrete, containment berms dozed into ponds, earthwork to reconfigure/cover waste piles, placement of to
84	Section 33	Mining Unit 33, Branson, Section 29	Rio Algom	Rio Algom	underground	1959	2002	d	28.00		1994 June Quivira reclaimed
85	Section 35	Elizabeth, Section 36	Rio Algom	Rio Algom	underground	1971	2002	d	40.00		

Summary of mines by mine working mode and production categories
Ref. 61

Mine workings mode category	Production category	Number of mines
Surface	<20,000 lbs U_3O_8	10
	20,000—200,000 lbs U_3O_8	5
	200,000—2 million lbs U_3O_8	1
Surface and underground	20,000—200,000 lbs U_3O_8	6
	200,000—2 million lbs U_3O_8	3
	2 million – 20 million lbs U_3O_8	1
Underground	<20,000 lbs U_3O_8	5
	20,000 – 200,000 lbs U_3O_8	15
	200,000—2 million lbs U_3O_8	20
	2 million – 20,000 million lbs U_3O_8	19
TOTAL		**85**

Notes:
Fig_index no. = reference number that has been assigned to mines on figures within this document

MINE NAME = "popular name"
ALIASES = alternate mine names
SURFACE OWNERSHIP = Surface ownership
MINERAL OWNERSHIP = Mineral ownership
MINING_MET = surface, underground, or in-situ leach [see Figure 1]
1st YEAR = Year of first uranium production
LAST YEAR = Year of final uranium production (does not indicate continuous production)
PRODUCTION = NMBGMR production categories [see Figure 1].

- e > 20 million lbs U3O8
- d 2 - 20 million lbs U3O8
- c 200,000 – 2 million lbs U3O8
- b 20,000 – 200,000 lbs U3O8
- a < 20,000 lbs U3O8
- f included with another mine
- u production unknown

DISTURBED = Extent of disturbance in acres
RADIATION = any known radiological measurements at the site
RECLAMATION = reclamation details, including dates, actions/abatement completed

Table 2: ACLs for the Anaconda Bluewater Uranium Mill in comparison to ground water regulation standards

Alluvial aquifer

Contaminant	ACL (mg/l; Ref. 35, p. 4)	Maximum Contaminant Limit (MCL; [page number in Ref. 9])	New Mexico Water Quality Commission (NMWQCC) standards (mg/l ([page number in Ref. 11])
Molybdenum	0.10	NA	1.0 [13]
Uranium	0.44 (300 pCi/L)	0.30* [431]	0.30 [12]
Selenium	0.05	0.05 [428]	0.05 [12]

San Andres aquifer

Contaminant	ACL (mg/l; Ref. 35, p. 4)	Maximum Contaminant Limit (MCL; [page number in Ref. 9])	New Mexico Water Quality Commission (NMWQCC) standards (mg/l ([page number in Ref. 11])
Selenium	0.05	0.05 [428]	0.05 [12]
Uranium	2.15	0.30 [431]	0.30 [12]

*converted from micrograms per liter (µg/l; Ref. 62)

Table 3: CERCLIS status of individual sites within the Site boundary
Ref. 36

Site name	CERCLIS ID	Reference page	Actions	Date completed	Reference page
Brown Vandever Mine	NND986669117	1	Discovery Preliminary Assessment Archive site Site inspection	03/01/1990 07/17/1990 12/10/1992 12/10/1992	2
Anaconda Co Bluewater Uranium Mill	NMD007106891	3	Discovery Archive site Preliminary Assessment	04/01/1980 04/01/1980 04/01/1980	4
Haystack Butte Mining District	NMD980878771	5	Discovery Preliminary Assessment Archive site Site inspection	09/01/1984 11/01/1984 12/01/1985 12/01/1985	6
Kerr-McGee Nuclear Corp	NMD005570015	7	Discovery Archive site Preliminary Assessment	02/01/1980 02/01/1981 02/01/1981	8
Mt. Taylor Uranium Mine	NMD000778605	9	Preliminary Assessment Discovery Site inspection Archive Site	04/01/1981 05/01/1981 04/01/1986 09/26/1994	10
Poison Canyon Mining District	NMD981600489	11	Discovery Preliminary Assessment Archive site Site inspection	12/01/1986 08/01/1987 10/01/1989 10/01/1989	12
UNC San Mateo Mine	NM1223075515	13	Discovery Preliminary Assessment Archive Site Site inspection	06/30/1988 01/20/1989 12/07/1995 12/07/1995	14
Febco Uranium Mine	NND986669166	15	Discovery Preliminary Assessment	07/16/1991 06/11/2001	16

Site name	CERCLIS ID	Reference page	Actions	Date completed	Reference page
Homestake Mining Company	NMD007860935	17	NPL listing	09/08/1983	18
			ROD	09/27/1989	18
			Five year review	09/27/2001	17
			Five year review	09/26/2006	17

Table 4: Analytical data from the Poison Canyon Mining District
Ref. 40, p. 2

Location	U_{238}	U_{234}	Th_{232}	Th_{230}	Ra_{226}	Pb_{210}	Vanadium	Lead	Copper
	pCi/g						µg/g		
Background									
A	5.53	6.80	0.50	6.86	6.30	6.60	6	<5	5
B	4.24	4.43	0.81	4.88	4.50	2.20	6	7	8
BJ #3A	1.29	1.22	0.40	3.23	3.92	2.00	12	6	9
Stream/pond sediments									
BJ Stream A	4.64	4.92	1.07	5.95	9.30	5.50	15	9	9
"Stock pond"	61.50	65.50	1.75	34.50	38.20	33.60	88	63	11
Waste rock/soils									
BJ #1	890.00	910		1150	1060	860	830	74	9
BJ #3B	140	142		175	72	93	66	5	<5
BJ #3C	5840	5730		5990	5600	4320	260	310	<5

Notes:
U_{238} = uranium 238
U_{234} = uranium 234
Th_{232} = thorium 232
Th_{230} = thorium 230
Ra_{226} = radium 226
Pb_{210} = lead 210
pCi/g = picocuries per gram
µg/g = micrograms per gram

Table 5: Ground water usage from wells within the Site boundary
Ref. 58

GROUND WATER USAGE			TOTALS
Consumptive			213
	Single domestic wells	203	
	Multiple domestic and community wells	10	
Irrigation, sanitary, industrial, and stock wells			241
Other well usages (including dewatering, exploration, mining, milling, oil, monitoring, no recorded use of right, observation, prospecting, construction, and no documented usage category)			79

7.0 References

1. U.S. Environmental Protection Agency, December 1990. 40 CFR Part 300, *Hazard Ranking System*, Appendix A, 55FR 51583.
2. U.S. Environmental Protection Agency, January 28, 2004. "Superfund Chemical Data Matrix."
3. U.S. Geological Survey, date unknown. "National Hydrography Dataset (NHD)—high resolution."
4. U.S. Department of Agriculture Natural Resources Conservation Service (USDA/NRCS), 1963-1997. Enhanced digital raster graphic 30x60 1:100,000.
5. Earth Data Analysis Center, January 1, 1994. "New Mexico County Boundaries."
6. Gallaher, Bruce M. and Steven J. Cary (Health and Environment Department, New Mexico Environmental Improvement Division), September 1986. "Impacts of uranium mining on surface and shallow ground waters, Grants Mineral Belt, New Mexico."
7. New Mexico Energy, Minerals and Natural Resources Department Mining and Minerals Division, June 19, 2007. "New Mexico abandoned and inactive uranium mines" (draft version).
8. U.S. Nuclear Regulatory Commission, accessed December 24, 2007. "Materials License SUA-1471, amendment no. 40." Accessed from online ADAMS database.
9. U.S. Environmental Protection Agency, accessed December 24, 2007. National Primary Drinking Water Regulations. 40 CFR 141.62 and 141.66.
10. U.S. Environmental Protection Agency, accessed December 24, 2007. National Secondary Drinking Water Regulations. 40 CFR 143.3.
11. New Mexico Water Quality Control Commission, accessed December 24, 2007. Environmental protection; water quality; ground and surface water protection; 20.6.2 NMAC.
12. Homestake Mining Company of California and Hydro-Engineering, LLC, March 2007. "2006 annual monitoring report/performance review for Homestake's Grants project pursuant to NRC license SUA-1471 and discharge plan DP-200."
13. Homestake Mining Company, 2007. Historical ground water sample database in MS Excel format.
14. Bahar, Dana (New Mexico Environment Department), October 17, 2007. "Request for NRC and DOE San Andres aquifer sampling due to concerns relating to the Anaconda Bluewater Mill and Homestake Uranium Mill sites, New Mexico." Letter to Mr. Chris Clayton, U.S. Department of Energy and Mr. Ron Linton, U.S. Nuclear Regulatory Commission. *Data in attachments are derived from Ref. 13.*
15. Hydro-Engineering, L.L.C. (for Homestake Mining Company of California), December 2001. "Ground-water hydrology for support of background concentration at the Grants reclamation site"
16. McLemore, Virginia T., 2007. "Uranium resources in New Mexico." SME preprint for 2007 annual meeting.

17. U.S. Census Bureau, 2006. "2006 American community survey data profile highlights [for] McKinley County, New Mexico." Accessed on January 15, 2008 from http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=Search&geo_id=&_geoContext=&_street=&_county=mckinley&_cityTown=mckinley&_state=04000US35&_zip=&_lang=en&_sse=on&pctxt=fph&pgsl=010.
18. U.S. Census Bureau, 2006. "TM-M2. Persons per square mile: 2006." Accessed on January 15, 2008 from http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-tree_id=806&-_MapEvent=zoom&-context=tm&-errMsg=&-_useSS=N&-_dBy=050&-redoLog=false&-_zoomLevel=7&-tm_name=PEP_2006_EST_M00090&-ds_label=2006%20Population%20Estimates&-tm_config=|b=50|l=en|t=806|zf=0.0|ms=thm_def|dw=1.1191768332529404|dh=0.6821102375443742|dt=gov.census.aff.domain.map.EnglishMapExtent|if=gif|cx=-108.10616483788615|cy=35.79252105411986|zl=6|pz=6|bo=316:314|bl=|ft=335:332:331|fl=204:369:368|g=01000US|ds=PEP_2006_EST|sb=86|tud=false|db=050|mn=0|mx=70739|cc=1|cm=1|cn=5|cb=|um=Persons/Sq%20Mile|pr=0|th=PEP_2006_EST_M00090|sf=N|sg=&-PANEL_ID=tm_result&-_pageY=&-_lang=en&-_pageX=&-geo_id=01000US&-CONTEXT=tm&-_mapY=&-_mapX=&-_latitude=&-format=&-_pan=&-ds_name=PEP_2006_EST&-_longitude=&-_changeMap=ZoomIn#?341,327.
19. U.S. Census Bureau, 2000. "Cibola County, New Mexico Census 2000 demographic profile highlights." Accessed on January 15, 2008 from http://factfinder.census.gov/servlet/SAFFFacts?_event=Search&geo_id=&_geoContext=&_street=&_county=cibola&_cityTown=cibola&_state=04000US35&_zip=&_lang=en&_sse=on&pctxt=fph&pgsl=010&show_2003_tab=&redirect=Y.
20. New Mexico Environment Department Drinking Water Bureau, accessed January 15, 2008. San Mateo MDWCA (query to SDWIS).
21. U.S. Census Bureau, 2000. "Census 2000 demographic profile highlights [for] Grants, New Mexico." Accessed January 15, 2008 from http://factfinder.census.gov/servlet/SAFFFacts?_event=Search&geo_id=16000US3548620&_geoContext=01000US%7C04000US35%7C16000US3548620&_street=&_county=Grants%2C+nm&_cityTown=Grants%2C+nm&_state=04000US35&_zip=&_lang=en&_sse=on&ActiveGeoDiv=geoSelect&_useEV=&pctxt=fph&pgsl=160&_submenuId=factsheet_1&ds_name=DEC_2000_SAFF&_ci_nbr=null&qr_name=null&reg=null%3Anull&_keyword=&_industry=.
22. U.S. Census Bureau, 2000. "Census 2000 demographic profile highlights [for] Milan village, New Mexico." Accessed January 15, 2008 from http://factfinder.census.gov/servlet/SAFFFacts?_event=Search&geo_id=&_geoContext=&_street=&_county=Milan%2C+nm&_cityTown=Milan%2C+nm&_state=04000US35&_zip=&_lang=en&_sse=on&pctxt=fph&pgsl=010&show_2003_tab=&redirect=Y.

23. Western Regional Climate Center, accessed January 7, 2008. Monthly climate summary for Grants Airport, New Mexico 5/1/1953 to 6/30/2007. Accessed from http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?nm3682.
24. Western Regional Climate Center, accessed January 7, 2008. Monthly climate summary for San Mateo, New Mexico 4/1/1918 to 2/29/1988. Accessed from http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?nm7918.
25. Western Regional Climate Center, accessed January 7, 2008. Prevailing wind direction data for the Grants airport 1992-2002. Accessed from http://www.wrcc.dri.edu/htmlfiles/westwinddir.html.
26. Cox, Al (Homestake Mining Company), December 31, 2007. Personal communication to David L. Mayerson.
27. Western Regional Climate Center, accessed January 9, 2008. "Bluewater Creek New Mexico wind rose and tables." Accessed from http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?nmXBLC.
28. Western Regional Climate Center, accessed January 9, 2008. "Bluewater Ridge New Mexico wind rose and tables." Accessed from http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?nmXBLR.
29. U.S. Bureau of Land Management New Mexico State Office (compiler), 2007. "Master Title Plats (surface ownership/management in the State of New Mexico)."
30. U.S. Nuclear Regulatory Commission, August 2006. "Bluewater: New Mexico Disposal Site fact sheet."
31. U.S. Nuclear Regulatory Commission, December 4, 2007. "Rio Algom—Ambrosia Lake." Accessed on January 29, 2008 from http://www.nrc.gov/info-finder/decommissioning/uranium/rio-algom-ambrosia-lake.html.
32. U.S. Department of Energy, Office of Legacy Management, October, 2007. "Ambrosia Lake, New Mexico, Disposal Site fact sheet." Accessed on January 29, 2008 from http://www.lm.doe.gov/documents/sites/nm/ambrosia/fact_sheet/ambrosia.pdf.
33. INTERA, Incorporated, October 26, 2007. "Evaluation of impacts from Section 35 and 36 mine dewatering, Ambrosia Lake Valley, New Mexico."
34. U.S. Nuclear Regulatory Commission, October 3, 1997. "NRC transfers responsibility for New Mexico uranium mill tailings disposal site to DOE." No. 97-146.
35. U.S. Nuclear Regulatory Commission, 1996. Materials license no. SUA-1470, amendment no. 30.
36. U.S. Environmental Protection Agency, accessed January 1, 2008. Selected query results for McKinley and Cibola counties, New Mexico, from CERCLIS database. Accessed from http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm.
37. U.S. Department of Energy, July 1996. "Long-term surveillance plan for the Ambrosia Lake, New Mexico disposal site." DOE/AL/62350-211, Rev. 1.
38. U.S. Forest Service, accessed January 29, 2008. "Southwestern Region Environmental Compliance and Protection Program and Abandoned

Mines Program." Powerpoint presentation accessed from http://www.fs.fed.us/geology/r3-overview.ppt.

39. Sitzler, Dave and Don Zoss (Bureau of Land Management), September 20, 1985. "Abandoned mine inventory pilot project report."
40. Halasan, Corazan and Mike Sanders (New Mexico Environment Department), July 1989. "Table 1: Poison Canyon Mining District chemical data—solids/inorganics."
41. Taylor, Bill (affiliation unknown), July 17, 1990. "Superfund site strategy recommendation [for the] Navajo Brown Vandever Uranium Mine, NMD986669117).
42. Brod, Robert C. and William J. Stone, 1981. "Hydrogeology of Ambrosia Lake—San Mateo area, McKinley and Cibola counties, New Mexico." New Mexico Bureau of Mines and Mineral Resources Hydrogeologic sheet 2.
43. New Mexico Environment Department Drinking Water Bureau, accessed February 7, 2008. Tri-State Generating Station (query to SDWIS).
44. New Mexico Environment Department Drinking Water Bureau, accessed January 15, 2008. ARCO (Anaconda) Coal Co—Bluewater Mill (query to SDWIS).
45. New Mexico Environment Department Drinking Water Bureau, accessed January 15, 2008. Homestake Mill (query to SDWIS).
46. U.S. Environmental Protection Agency, September 1991. "Guidance for performing Preliminary Assessments under CERCLA." EPA/540/G-91/013, Publication 9345.0-01A.
47. Mayerson, David L., 2007. Field notebook for Grants Uranium belt projects.
48. New Mexico Environment Department Drinking Water Bureau, accessed January 15, 2008. Grants domestic water system (query to SDWIS).
49. New Mexico Environment Department Drinking Water Bureau, accessed January 15, 2008. Milan community water system (SDWIS query).
50. New Mexico Environment Department Drinking Water Bureau, accessed January 15, 2008. Golden Acres Trailer Park (SDWIS query).
51. New Mexico Environment Department Drinking Water Bureau, accessed January 15, 2008. Mount Taylor Millworks (SDWIS query).
52. Appaji, Sai (EPA) to David L. Mayerson, NMED, January 17, 2008. "CSM for HMC." Email.
53. Earth Data Analysis Center, December 1, 1995. New Mexico GPS Roads" (ArcGIS shape file).
54. Earth Data Analysis Center, May 1, 1995. "Cities and towns [in New Mexico]" (ArcGIS shape file).
55. Mayerson, David L.(NMED) to Suzan Arfman (NMDoIT), January 9, 2008. "Categorization of minesites for map presentation." Email.
56. Mayerson, David L. (NMED) to Suzan Arfman (NMDoIT), January 15, 2008. "Re: Mines." Email.
57. Green, Gregory N. and Glenn E. Jones, August 2001. "The digital geologic map of New Mexico in ARC/INFO format."

58. New Mexico Office of the State Engineer, May 19, 2006. "may_06_wells." ESRI point shapefile.
59. New Mexico Office of the State Engineer, February 9, 2007. "W.A.T.E.R..S. use codes." Accessed on January 29, 2007 from http://www.ose.state.nm.us/PDF/WaterRights/WATERS/UseCodes-2007-02-09.pdf.
60. Mayerson, David L. (NMED) to Suzan Arfman (NMDoIT), January 15, 2008. "RE: Wells table." Email.
61. Arfman, Suzan (NMDoIT) to David L. Mayerson (NMED), February 11, 2008. "RE: More information." Email.
62. Online conversions, accessed January 14, 2008. Accessed from http://www.onlineconversion.com/density_common.htm.